Chapter 3
Active Sensor Planning – the State-of-the-Art

The aim of sensor planning is to determine the pose and settings of a vision sensor for undertaking a vision task that usually requires multiple views. Planning for robot vision is a complex problem for an active system due to its sensing uncertainty and environmental uncertainty. This chapter describes the problem of active sensor planning formulated from practical applications and the state-of-the-art in this field.

3.1 The Problem

An active visual system is a system which is able to manipulate its visual parameters in a controlled manner in order to extract useful data about the scene in time and space. (Pahlavan et al. 1993)

Active sensor planning endows the observer capable of actively placing the sensor at several viewpoints through a planning strategy. In the computer vision community, when active perception became an important attention to researchers, sensor planning inevitably became a key issue because the vision agent had to decide “where to look”. According to task conditions, the problem is classified into two categories, i.e. model-based and non-model-based vision tasks.

About 20 years ago, Bajcsy discussed the important concept of active perception (Bajcsy 1988). Together with other researchers” initial contributions at that time, the new concept (compared with the Marr paradigm in 1982) on active perception, and consequently the sensor planning problem, was thus issued in vision research. The difference between the concepts of active perception and the Marr paradigm is that the former considers vision perception as the intentional action of the mind but the latter considers it as the procedural process of matter.

Therefore, research of sensor planning falls into the area of active perception (Bajcsy 1988). It introduces the idea of moving a sensor to constrain interpretation of its environment. Since multiple 3D images need to be taken and integrated from different vantage points to enable all features of interest to be measured, sensor placement which determines the viewpoints with a viewing strategy thus becomes critically important for achieving full automation and high efficiency.

The problem of sensor placement in computer vision was addressed by Tarabanis et al. (1995) as: “for a given information concerning the environment (object under observation, sensor available) and concerning the task that the system
must achieve (detection of characteristics, object recognition, scene reconstruction), to develop some automatic strategy to determine the sensor parameters (the position, the orientation and the optical parameters of the sensor) to carry out the task satisfying some criteria.”

Today, the roles of sensor planning can be widely found in most autonomous robotic systems. According to the task conditions, the planning scheme can be applied on different levels of vision perception as illustrated in Fig. 3.1.

### 3.2 Overview of the Recent Development

The early work on sensor planning was mainly focused on the analysis of placement constraints, such as resolution, focus, field of view, visibility, and conditions for light source placement in 2D space (Lin et al. 1996). A viewpoint...